REPORT

Knickerbocker Pool & Aquatic Equipment/ Systems Improvement Analysis and Recommendations

Troy, NY

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CHA Project No: 32892

PREPARED FOR:

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0.0 PURPOSE/BACKGROUND

CHA conducted an extensive site assessment of the outdoor swimming pool at the Knickerbocker Pool facility in north Troy, NY on April 25th, 2017 for the purposes of 1) swimming pool and associated equipment analysis and deterioration/end of life valuation, 2) conformance to current New York State Health Department Swimming Pool code, 3) conformance to life safety and ADA requirements, 4) record observances and recommendations of potential pool space and equipment upgrades and 5) identify any structural deficiencies that may impact structural performance and the assess the remaining life expectancy of the pool. This report includes our findings as to what upgrades should be considered as well as provides estimated budgetary costs with the understanding that all upgraded items need to last a minimum of a 5 year timespan.

It is the intent of this report to provide the City with CHA's professional opinion of all necessities to equipment/upgrades that may be in jeopardy of failure or deterioration detrimental to the operation of the facility. It is our understanding that the outdoor pool is utilized for residents within the City during the summer months of the year (~mid June to Labor Day). The facility is then closed for the remainder of the year.

In an effort to make this study as comprehensive as possible, we have rated each of the listed aquatic related upgrades with a Degree of Importance Factor (DIF) of which we have assigned ranges from #1-3. DIF #1 rating is critical to the proper functioning of the facility. They include equipment that has reached their end of life and are no longer repairable. They also include all code and/or safety violations that pertain to the site. These recommendations should be top on the list of priorities. DIF#2 is of somewhat importance to consider and borders between high and low importance. Items nearing their end of useful life or items that will eventually need repairs are included in this category. DIF #3 is currently not critical to the normal operation of the facility but should be considered. It is important to note that the recommendations listed are only recommendations. Additional upgrades can certainly be added and for that matter, those listed in this report can be removed if not deemed appropriate or amenable with the City. The intent is to inform the City of the existing problematic areas in order to make the best possible choices during the future improvement phase of this project.

The structural portion of our evaluation consisted of our visual inspection to determine the condition of the general pool structure and associated ancillary infrastructure. Our assessment focused on the remaining life expectancy of the pool components in order to provide comprehensive recommendation for repair/replacement. Lastly, the structural portion within this report endeavored to identify any structural deficiencies and facility shortfalls that may impact the overall structural performance. Non-structural items that do not pose any safety hazards have been considered as maintenance items and may not be covered in this report.

1.0 SITE HISTORY

The Knickerbocker swimming pool is an in-ground outdoor public pool used for recreation and is located along the west area of the Knickerbocker Park in Troy, New York. The pool was constructed in the 1950's and is T-shaped, measuring approximately 100 feet in the east-west direction and 75 feet in the north-south direction. The pool depths range from three feet at the shallow end to 10 feet at deep end (diving side) and are clearly marked on the pool walls. The total floor area of the pool is approximately 5,225 square feet.

The pool equipment filter room is located behind the pool wall on the west side of the pool structure. The amenities building is located on the east side of the pool. The surrounding pool deck walking surface is constructed of square and rectangular precast concrete panels.

The pool shell is constructed of 1/2 inch thick metal plate. The interior of the pool has an epoxy paint pool finish and a protective coating on the outside walls. The exterior face of the pool walls are braced with C8x11.5 steel channels and spaced approximately four feet on center. The channels are welded to the steel base plates at the bottom and welded a built-up steel beam at the top.

The filter building consists of load bearing concrete masonry walls with a brick veneer facade and supports a six inch thick reinforced concrete roof. Five inch thick precast concrete deck panels are laid over the roof slab. The pool deck consists of five inch thick reinforced concrete jointed in square and rectangular pattern.

The pool deck is reinforced concrete which has approximately 10,900 square feet of surface area. The amenities building (bathhouse) consist of load bearing concrete masonry walls with a brick veneer facade and support a built-up roof membrane system. It has an approximate surface area of 3,800 square feet.

2.0 AQUATIC SITE RELATED DEFICIENCIES

2.1 Pool Finish Upgrade

One of the key elements that we noted during our investigation for update is the pool's existing finish. The pool's existing finish is a painted top coat. It has lasted well but is showing signs of degradation. Areas throughout the pool are spalling and separating from the steel base. Being the pool shell is steel, it is critical that a durable finish be applied and integral to avoid further deterioration of the shell. The *Pool Finish Upgrade* has several options available to select from. To assist you, we have created a Pool Finish Comparison Narrative (see Appendix A) which lists six finish options with general pros and cons to each. To further assist, we have also created a Pool Liners- Pros and Cons summary worksheet (included in Appendix A) which is based on the key factors. Work within this section shall include at minimum 1) protection of all existing pool equipment (eg: step area, grab rails, gutter, etc.), 2) preparation of existing pool's surface for proper application/adhesion of the new pool finish, and 3) application of the finish selected. This scope of work will include working around of all of the wall and floor penetrations (as necessary) such as the main drains, wall returns, etc. Depending on the surface selected, work may require removal of existing painted finish via sandblasting. The pool must be free of leaks after the finish is completed and warranty should cover workmanship.

DIF #1: Highly Recommended

2.2 Pool Concrete Deck Repairs

Several areas around the pool deck are clearly in need of repairs.

Chunks of concrete were removed from the pool deck. Several large cracks were observed and spalling is occurring at some locations. At minimum, portions of the deck needs repairs and/or full replacement in order to open this site.

DIF #1: Highly Recommended

2.3 Underground Piping Repairs

One of the standout Health code violations found at the existing pool has to do with the pool supply inlets and piping. It is clear that the pool's supply piping has been compromised as evidence from the amount of sand fines found within the pool. This occurs when the buried pool piping has been damaged to the point where the pipe sub-base fill is being extracted through the pipe and dumped into the pool. This not only suggests that the pool piping is no longer fully functional but the under deck may be undermined. The only solution to this problematic condition is to locate the damaged pipe and make the necessary repairs. We have estimated a few spots but without proper scoping, this is simply a best guess as to the existing damage.

DIF #1: Highly Recommended

2.4 Main Drains

A total of two *main drains* were found during our facility walkthrough. No issues found as they have been located and sized to accommodate the pool. Aquastar VGBA compliant grates were installed on the drains.

2.5 Pool Gutter

The existing pool's *Gutter* appeared to be in fair condition as there were some signs of age degradation. It does provide continuous skimming throughout the pool's perimeter with the exception of the stair area (gutter is not found throughout the steps).

This is technically not compliant with New York State swimming pool code and should be addressed. However, it is important to mention that the gutter's main purpose is for controlling wave surge or splash of which your gutter appears to have done the job. It is not supposed to function as the main return to the pump for circulation. This pool however does just this as it does not function using a surge tank. At minimum, the gutter should be corrected to comply with NYS Health code.

DIF #1: Highly Recommended

2.6 Wall Returns Repairs and Replacement

The pool's return system utilizes wall return inlets placed throughout the pool perimeter in order to provide for adequate circulation. We have estimated there are approximately 20 wall returns total. The locations of these returns are correctly positioned which we would not change.

We did however notice degradation around some of the returns which indicates that the returns themselves may be corroding and not functioning adequately. It was difficult to tell what the returns were made of but if they are original to the original pool construction, it may be time to initiate

replacement with similar non-corrosive returns. For this reason, we have given this a higher priority.

DIF #1: Highly Recommended

2.7 Water Slide Repairs/ Replacement

An approximate 12 foot high permanently installed double flume waterslide is located at the deep end of the pool. The slide is most likely a popular attraction to the facility's patrons. The slide structure is made of steel which is painted. The slides flumes are an enclosed tube style and are plastic. The slide's steps and upper platform is a perforated metal material and are showing signs of corrosion and deterioration. In general, the slides are in fair condition. The metal steps, platform and framework however are in poor condition as the steel members are showing signs of corrosion which should be abated and/or replaced.

DIF #2: Somewhat Important

2.8 Americans with Disabilities Act (ADA) Swimming Pool Lift Addition

The 2010 ADA Standards (formerly known as Revisions to Title II and III of the Americans with Disabilities Act) were recently announced in July 2010 and took effect March 15, 2011 with compliance required by March 15, 2012. They require that recreational facilities (which include swimming pools, wading pools, and spas) not covered under the original 1991 Americans with Disabilities Act, be accessible to disabled users. This will certainly apply to the existing facility and is a critical item for code compliance, therefore we are recommending this be completed. When it comes to the lengthy list of areas covered under the new rules, providing access to pools is among the top priorities. Pools with 300 linear feet of wall must include two means of access, one of which must be a lift or sloped entry (ramp). Pools less than 300 linear feet only need one means of access but it must be a lift or sloped entry. During our site visit, we did not notice a primary means of access present into the pool. Therefore, we are recommending this be added to be fully complaint with code.

DIF #1: Highly Recommended

2.9 Stair Rails Replacement

The existing stair rail is manufactured of stainless steel (most likely Type 304). The railing itself is in fairly good condition. However, there is only one railing as the other has been destroyed. We should provide a second stair rail (identical to the existing) as if the pool requires a secondary means of ADA access, this would be the easiest and least costly to complete.

DIF #1: Highly Recommended

2.10 Life Safety & Deck Equipment

Lifeguard chairs were found on site and appeared

to be in adequate condition. Quantities appeared to be correct and positioned in good locations. Chairs were elevated in height, were permanently mounted and were manufactured from stainless steel and fiberglass. We did not find Ring buoys/rescue tubes which are integral for use involving lifeguard rescue. Although not a mandatory requirement, lifeguard umbrellas were not seen in storage were are considered valuable for lifeguard protection from the sun. A spine board was also not found at the site which is important. It is a required item at all public swimming pool facilities and is used in case of serious injury to patrons. Ladders were not seen installed and would need to be provided at the various locations currently located around the pool's perimeter. We would recommend these additions as well as a qualified water test kit as this is also required / recommended.

DIF #1: Highly Recommended

2.11 Depth Marker Replacement

The facility's existing depth markers are positioned both on the pool deck and around the pool's gutter face perimeter. The depth markers are all painted and are of a contrasting color to visually indicate location water depth. The depth markers do in fact comply with NY State Swimming pool code.

Location of depth markings. Depth of water shall be plainly marked at or above the water surface on the vertical pool wall and/or on the edge of the deck at maximum and minimum points and at break between the deep and shallow portions, and at intermediate two-foot increments of depth, spaced at not more than 25-foot intervals. Markings shall be on both sides and ends of the pool. Where depth markings cannot be placed on the vertical walls above the water level, other means shall be used so that the markings will be plainly visible to persons in the pool. Water depth shall be measured at a point three feet from the pool wall.

Size of depth markings. Depth markings shall be in numerals of four inch minimum height, followed by the words "foot depth" or "feet deep," and with color contrasting with background. Depth markers must be of durable material and permanently installed.

However, the paint is beginning to wear and should be considered for being touched up.

DIF #3: Suggested

2.12 Pool Shell Condition (Steel)

Refer to Structural Findings in section 5.0.

3.0 AQUATIC MECHANICAL EQUIPMENT DEFICIENCIES

3.1 Filter System Replacement

The existing *filtration system* is a single tank steel vertical high rate sand filter manufactured by Neptune Benson which is showing severe sign of corrosion. It without a doubt should be replaced. High Rate Sand is one of the more common methods of swimming pool filtration and is a reliable and low maintenance option. Although the nameplate is difficult to read with rust staining present, we believe the filter is

original to the pool's construction which would place it at or around 40 years old. Fiberglass filtration systems have been around for a number of years and have proven to be both resist to the demands of corrosion while still maintaining the structural integrity of the pressure (and vacuum) conditions experienced. We would therefore recommend that a fiberglass High Rate Sand filtration system with automatic controls be installed.


DIF #1: Highly Recommended

3.2 Recirculation Pump Replacement & Additional Backup Pump

The *recirculation pump* is the heart of the recirculation system. As per Department of Health swimming pool code, it must run 24/7. The existing recirculation pump is a flooded suction type and has reached the end of its typical life expectancy. It must be replaced. We would also recommend a second pump be added for two reasons: 1) to create a backup in case one of the pump motors goes down and 2) to be able to alternate between the pumps to evenly distribute the normal wear. The pumps must be NSF listed as this is a prerequisite according to State Sanitary Code. We also recommend that all wetted parts of the pumps be epoxy coated to help avoid interior surface corrosion. We recommend two Aurora pumps (HP TBD) be installed (with isolation valving) in the same location as the existing pump.


DIF #1: Highly Recommended

3.3 Strainer Replacement

The *strainer* is meant to trap large particles from entering and damaging the recirculation pump. The existing strainer is manufactured out of steel and has been susceptible to corrosion. It is showing signs of age and significant staining. We recommend a non-corrosive FO eccentric style fiberglass strainer as manufactured by Fluidtrol be installed in place of the existing. Additionally, a spare stainless steel strainer basket will be required per NY State Health Dept. code.

DIF #1: Highly Recommended

3.4 Partial PVC Pipe and Butterfly Valve Replacement

The existing pool piping has been replaced over time with schedule 80 PVC which was a good observation. However, some of the butterfly valves are either non-functional or nearing the end of their life. Valves are in need of replacement particularly around the chemical injection lines which were corroded. This recommendation is intended to include the materials and installation of new valves that require replacement.

DIF #1: Highly Recommended

3.5 Pool Chemical Systems Improvements

There are two basic components that make up a commercial swimming *pool's chemical system*, pH control and water disinfectant. pH is the single most important element in swimming pool water chemistry. In pools, a slightly alkaline pH of 7.4 to 7.6 is most desirable. A chemical is needed to lower the pH to keep it at or near the desired pH range. Your pool currently controls the pH level with Muriatic Acid which is a liquid. In our assessment of your pH control equipment, we feel that the existing acid tank is adequate and would not recommend any changes. We would however recommend the replacement of the peristaltic metering pump in order to deliver the acid at the appropriate rate. The second component of a pool's chemical system is the disinfectant that's purpose if to sanitize the pool water. Your pool's disinfection system utilizes sodium hypochlorite (also sometimes referred to as liquid chlorine) which is a very common method of sanitizing a pool. The chemical itself is kept in a non-corrosive container and is injected into the pool's return line by way of a peristaltic metering pump (similar to that of the acid). From our observations, we found nothing worth changing in terms of the container or the chemical used. The chemical controller and flow cell accounts for all of the diagnostics

and senses when each chemical should be injected to the water body. This equipment must be correctly calibrated and properly maintained. Your control unit is nearing the end of its useful life and for this reason, we are recommending this specific equipment be replaced.

DIF #1: Highly Recommended

Spill Containment: This improvement would be a priority on our recommendations list as it involves safety. The existing chemical enclosures are currently mounted on the mechanical room floor and susceptible to spills. For this reason, we would recommend spill platforms for the pool chemicals.

DIF #1: Highly Recommended

Chemical Feed System Repairs: This improvement is added to account for some of the miscellaneous items that will require repair. The existing chemical feed lines should be replaced and properly installed within conduit to the injection ports which may also need to be replaced.

DIF #1: Highly Recommended

3.6 Pipe Supports Replacement

Some of the existing *piping supports* were in very poor condition and had deteriorated beyond repair. This improvement is intended to replace the few supports that were either on their way out or no longer functioning. We would recommend that in a pool mechanical room environment, stainless steel supports be installed.

DIF #1: Highly Recommended

3.7 Flow Monitoring Equipment

One small but important addition would be to add to the pool return a functioning flow sensor and meter to enable the staff to properly check and monitor the recirculation flow rate. This is an important part of ensuring that the pool pump is operating correctly and providing the turnover time (which is a Department of Health requirement). The existing flow meter has been a good temporary fix but should be replaced.

DIF #1: Highly Recommended

3.8 Flow Controller Addition

A flow controller is missing from the pool recirculation supply line. As this is a Department of Health requirement, we are recommending that this equipment be added.

DIF #1: Highly Recommended

3.9 Check Valve Addition

During our site inspection of the mechanical equipment, the absence of a check valve after the pump discharge was noted, as well as the absence of an isolation valve. A check valve on the discharge side of the circulating pump is typically considered a necessity. A check valve that will eliminate backflow where the system is installed below grade is also very desirable and is typically installed after the pump discharge. Similarly, a butterfly valve will provide isolation necessary for when the pump needs to be taken out of service. This recommendation includes the materials and installation of these two types of valves.

DIF #3: Suggested

4.0 FILTER ROOM MISCELLANEOUS DEFICIENCIES

4.1 Electrical Repairs/Improvements

This addition is specifically for any miscellaneous *electrical improvements* within the existing mechanical room. Although the electrical at this facility has recently been updated, it shall include an inspection by a licensed electrician, work involved in changing all electrical outlets to GFCIs, and any miscellaneous replacement equipment controls and/or installations.

DIF #1: Highly Recommended

4.2 Structural Repairs within Mechanical Room & Through Swimming Pool Steel Shell

Damage was extensive. See Structural assessment and findings.

4.3 Cosmetic Repair Work

This addition is specifically for any miscellaneous *cosmetic repair improvements* within the existing mechanical room. It shall include repair of all cracks in the walls and floor of the mechanical room, repairs to the backwash pit, and any surface treatment (prime/paint) of the walls and floor as required.

DIF #3: Suggested

4.4 HVAC in Mechanical Room

The existing mechanical room is severely corroded partly due to a lack of ventilation. This should be further investigated and a solution put in place. We are carrying this to account for this necessity.

DIF #1: Highly Recommended

5.0 OBSERVED STRUCTURAL DEFICIENCIES

5.1 Ratings Criteria

The following terms are used to describe the condition of a structural system or component are listed and defined below. When the term is applied to an overall structure or system, this does not indicate that all elements of the structure or system are in the same condition.

- Excellent - “As New” Condition.
- Good - The structural system is sound and performing its function, although it shows signs of wear and may require some minor repairs, mostly routine.
- Fair - The structural system is still performing adequately at this time, but needs “priority” and/or “routine” repairs to prevent future deterioration and to restore it to good condition.
- Poor - The structural system cannot be relied upon to continue to perform its original function without “immediate” and/or “priority” repair.

5.2 Pool & Filter Room Observances

a) We observed corrosion on the pool walls caused by water leaking through damaged welded connections between the pool wall and pool floor. At this location, there is also a corroded pipe

penetration caused by a damaged joint seal and water is leaking through the damaged joint. Similar conditions occur at other locations (*See Appendix B, Photograph Nos 4 and 8).*

b) We observed pitting of base plates caused by water leaking between pool wall and pool floor at several locations (*See Appendix B, Photograph No 5*).

c) We observed corroded channels and angles in several locations, up to 100% section loss caused by water leakage between pool wall and pool floor. (*See Appendix B, Photograph Nos 6, 7 and 9*).

d) At several location along the pool walls, CHA observed corrosion on the built-up beam caused by water infiltrating through joints in the precast concrete deck and cracks in the reinforced concrete roof deck (*See Appendix B, Photograph No 10*).

e) We observed a severely corroded wide flange beam which provides support to concrete roof deck. A plausible cause for the corrosion is from water leaking through the joints in the precast concrete deck and cracks in the reinforced concrete roof deck (*See Appendix B, Photograph No 11).*

f) We observed large concrete spalls and wide cracks with exposed reinforcement at the underside of the reinforced concrete roof deck. Water is leaking through cracks and joints of precast concrete deck panels and concrete roof deck. The water is corroding the reinforcement steel in the concrete causing the steel to expand and spall the concrete cover. This occurs at several locations along the underside of the concrete deck (*See Appendix B, Photograph Nos 12 13, 14, and 15).*

g) We observed wide cracks in the precast concrete deck caused by unequal settlement of the base support and a large opening in deck. Water is leaking through joints and the openings (*See Appendix B, Photograph No 16).*

h) We observed large concrete spalls and delaminated concrete at the previously patched locations caused by poor workmanship and or unsound patched material. This condition is typical for several locations (*See Appendix B, Photograph No 17*).

i) We observed a partially detached concrete stair from the pool deck and delamination of the protective epoxy coating (*See Appendix B, Photograph No 18*).

j) We observed heaving of the pool floor caused by differential settlement of the foundation (*See Appendix B, Photograph No 19*).

5.3 Amenities Building Observances

a) From the photographs provided by the City, we observed stepped cracks in load bearing wall and brick facade of the amenities building caused by foundation settlement. Similar condition exists at other locations (*See Appendix B, Photograph Nos 20 and 21).*

b) From the photographs provided by the City, we observed wide cracks in concrete slab on grade and large spalls on floor tiles caused by unequal settlement of the concrete slab on grade. Similar condition exists at other locations (*See Appendix B, Photograph Nos 22 and 23*).

c) From the photographs provided by the City, we observed severely corroded metal partition panel. Similar condition exists at other locations (*See Appendix B, Photograph No 24*).

6.0 CONCLUSIONS

6.1 Swimming Pool Aquatic Conclusions

The swimming pool's supply piping is questionable and may not provide the NYS Department of Health required circulation. Several code violations are identified (ADA access, DOH issues, etc.). Certain pool deficiencies noted above are important to the full functioning operation of the site.

6.2 Aquatic Equipment Conclusions

Most of the pool's filter, recirculation pump and chemical systems were in very bad shape. The filter system is potentially on the verge of failure as the corrosion level is in the severe stage. The filter internal area is also suspected to be full of corrosion. The recirculation pump probably will not operate to provide the DOH required turnover time.

6.3 Structural Conclusions

The overall condition of the pool is fair. The exposed metal wall is in good condition. No sign of distress were observed in the exposed metal floor plate on grade in the interior of the pool, therefore the pool floor is assumed to be in good condition. Water is leaking through the welded connection joints between the pool floor and the pool walls. Therefore the welded connections along the perimeter of the pool floor are assumed to be in poor condition. The built-up beam behind the pool wall is in good condition. The base plates behind the pool wall are in poor condition. The pipe penetrations are in poor condition. The braced channels and angles are in fair condition. The pool stair is in good condition. The filter building roof deck is in fair condition. The filter building bearing wall is in good condition. The pool walking surface deck is in poor condition. The bearing wall at the amenities building is in poor condition. The roof of the amenities building is in good condition. The slab-on-grade of the amenities building is in good condition.

7.0 RECOMMENDATIONS

It is our recommendation that the Knickerbocker facility remain closed for this 2017 summer season so that the highlighted issues can be adequately addressed. The below renovation recommendations have been based on the review of the existing systems and are provided to enable a minimum of 5 years of extended life to the facility. At a minimum, we would recommend the following:

1. Address all ADA & state swimming pool health code violations.
2. Upgrade all failing and/or failed equipment that is beyond repair (i.e.: filter system, recirculation pump, strainer, chemical systems, valves, piping and supports, etc.).
3. The severely corroded portion of the pool wall with section loss should be immediately repaired and reinforced.
4. The exposed pool wall in the filter room needs a protective coating.
5. The corroded reinforced channels and the angles behind the pool wall in the filter room should be replaced.
6. The welded connection joints between the pool floor and the pool wall should be repaired.
7. The unexposed part of the pool wall should be further examined.
8. All pipe penetration joints should be replaced.

9. The wide flange beam located at the underside of concrete roof deck in the filter room should be replaced.
10. All cracks and spalls on the underside of concrete roof deck should be repaired with an epoxy injection sealant.
11. Joints between the precast concrete deck panels should be sealed.
12. Replace the pool deck panels requiring replacement.
13. All spalls, openings and cracks in or on the precast concrete deck panels should be repaired.
14. An appropriate HVAC system should be added to the pool equipment room to abate the severe corrosion occurring in any renovation scenario.
15. A drainage system should be provided around the amenities building.
16. All cracks and spalls associated with the amenities building should be repaired.

The recommendations above are based on field observations of readily accessible areas of the structure. This report does not address any portion of the structure other than those areas noted, nor does it imply any warranty, either expressed or implied, for any portion of the existing structure. These recommendations assume no hazardous materials are encountered during renovation.

8.0 FULL SITE REPLACEMENT

As with any extensive renovation to an existing facility which is 50+ years old, it is prudent to evaluate the option of full demolition and constructing a brand new facility. To this end, we are providing a high level breakdown of probable costs assuming the pool and the support facilities would be of similar size shape and function. This cost of a new pool facility was prepared for comparison purposes and is an order of magnitude in today's dollars. It assumes that the pool would be constructed at the existing site. If an alternate site is chosen, there would likely be additional costs to ready the site that this estimate would not have.

It is important to mention that with the below estimated renovation costs and with the construction of a new pool, the life expectancy with normal maintenance and upkeep could be 30 years or more.

We have determined the probable construction cost if the City were to decide to replace the existing site with a new one of similar size.

1. Swimming Pool (Cast-In-Place reinforced concrete) = $1,250,000
2. Pool Mechanical & Chemical Equipment = $675,000
3. Amenities / Bathhouse = $855,000
4. Deck / Site = $150,000
5. Utilities = $250,000
6. Design/Contingency/Misc. Fees = $625,000

Total = $3,755,000

Appendix A

Pool Finish Comparison Narrative

1. ***Plaster Finish:*** Plastering is one of the more commonly installed pool finish in the industry and provides a classic look to the pool. Plaster is simply a type of mortar consisting of Portland cement, aggregates, and additives. It is usually about ½" thick so it covers any imperfections in the pool shell. It is one of the more economical ways to finish a pool. Plaster is normally white in color but when the pool is filled with water, the effect of plastering gives the pool a light blue color making it look extremely neat. Although it is one of the lesser expensive ways to finish a pool, it is definitely more prone to wear and tear. Because of it being constantly submerged and exposed to chemical treatments, plaster can be prone to staining and scaling. It is also susceptible to damage from impact. For these reasons, one should expect certain upkeep and refinishing if this finish is selected. However, plaster finishes have come a long way in terms of altering mix designs and adding exposed aggregate to enhance the durability. Although these 'deluxe' plaster finishes are more costly, they may be worth exploring to achieve a more durable and longer lasting product if this finish is selected. We **would** recommend this finish to your pool.

2. ***Tile Finish:*** Tile finishes are not as common for commercial pools but are perhaps the best finish available due to its look and longevity. Tile finishes were very popular years ago for pool construction. They are usually a ceramic material and provide a resort feel to the pool. They are very commonly used in conjunction with a plastered pool and are typically used at the waterline, step and bench nosings, and zero depth entry areas. A variety of colors and patterns are available to choose from. However, the Department of Health will limit this selection as the pool finish needs to be light or white in color for visibility reasons. A tile finish is extremely costly to install and is extremely labor intense. It has a great resistance to chemicals and normal wear and tear a pool will see. However, it is not easily repairable should this be required. It is also important to note that a tile finish in terms of its resistance to leaks is as only as good as the installers. Any imperfections or poor installation practices can result in a leaky pool. We **would not** recommend this finish to your pool.

3. ***Painted Finish (over existing surface):*** Your pool currently has a pained top coat finish. Although this particular pool finish is an available option, it is not the best selection. However, one big advantage to this pool finish is that it is the least costly to install. It however is also one of the most labor intense in terms of maintaining it. Having an outdoor pool and due to the size of the pools in question, you will most likely need to re-surface the pool areas every year or two. It will also not provide the look that the other options will display. This pool finish is usually chosen as a result of a very tight budget knowing that maintenance and upkeep will be essential and required. We **would** recommend this finish to your pool.

4. ***PebbleSheen (PebbleTec) Finish:*** Although this is one of the somewhat newer styles of pool finishes in the industry, it has been very well received by facilities around the country. The finish is just how it is described providing a pebble-like aggregate finish to the pool's surface. It has proven to be resistant to staining and provides durability which translates to relatively low maintenance. It also provides a sharp look to the pool. This type of finish is typically installed by a manufacturer's representative/installer as there is a specific and correct procedure to follow. It is our belief that this is a good practice as it ensures a correct installation (or in the unfortunate event it is not installed correctly, one would have means to go back to the manufacturer/installer for corrective measures). One of the major disadvantages to this finish is that it is one of the most costly. It would also require the removal of the existing painted finish and preparation of the surface for adherence. We **would not** recommend this finish to your pool.

5. ***Diamond-Brite (Quartz) Finish:*** Unlike traditional marble-based pool plaster, this finish made with natural quartz, is one of nature's hardest and purest minerals. Marble aggregates are easily dissolved by pool chemicals causing unsightly attaching and rapid deterioration. Quartz aggregates are typically unaffected by the harshest pool chemicals and have a very good resistance to permanent staining. The impervious quartz will resist stains and etching caused by harsh pool chemicals. It is also important to mention that the Quartz finish will increase hardness, improves bonding and reduces water penetration. This yields a very attractive yet durable pool finish. As a result,

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many people throughout the industry feel this is the best pool interior finish. Because the quartz aggregates are smaller than pebble finish surfaces, the surface is comfortable to bathers' feet. A Quartz finish is an ideal surface where wet, slippery conditions are a concern. Unlike plaster finishes, the Quartz finish can be drained and cleaned without being damaged. Maintenance is typically very minimal for this type of finish. It is however one of the more costly and would require removal of the existing finish. We **would not** recommend this finish to your pool.

6. ***Vinyl Liner Finish:*** Vinyl liner finishes are somewhat of an enigma to describe. They have been available for many years and been known to tear/puncture causing leaks. This has led to design improvements in vinyl lined pools some of which are now much more resilient to the leak problem. They provide somewhat of a pleasant look and feel to a pool as vinyl is a softer material that any of the other pool finishes. They are however more prone to damage. Under normal conditions, a vinyl lined pool will not need to be acid washed or painted during its lifespan and will last about the same length of time as a plaster surface. Although vinyl lining is much more common to residential style pools, this option is available to commercial applications. However, with the manufacturing limitations as to the size of the rolls produced/manufactured, the installation process of vinyl lining to a commercial pool is paramount to a water tight seal. Like any product, there are varying degrees of products on the market that are better quality in terms of materials and design in this category finish. Costs will vary somewhat based on this, but a better quality liner may be well worth the added initial cost. Due to the nature and sheer size of the pool at your facility, we feel that this finish option creates the potential of problematic conditions. We **would not** recommend this finish to your pool.

7. ***PVC Liner Finish:*** Like the vinyl liner finishes, PVC liner finishes are of similar application. However, they are MUCH more advanced and suited for larger commercial/institutional pools. The PVC material is much more durable than vinyl and resistant to punctures. They are also fabricated in much larger sections leaving less of a chance for problems during installation. PVC liners provide a pleasant look and feel to a pool. The installation process of PVC lining to a commercial pool has been perfected by certain companies and will provide a water tight seal. Being the PVC liner is thinner than some of the other finishes mentioned, this finish may not require the removal of the existing finish which is another large advantage. Certain PVC liner manufacturers also provide a 10-20 year warranty on their products. A big disadvantage of this finish is that it can be extremely costly to repair and/or replace if vandalism should occur. We **would not** recommend this finish to your pool.

Pool Liners- Pros and Cons

Category	Finish						
	Plaster	Tile	Painted surface	Pebble Sheen	Diamond Brite	Vinyl Liner	PVC Liner
Durability	2	4	2	3	3	2	3
Life Expectancy	2	4	1	3	3	2	3
Cost	4	1	4	1	1	3	3
Maintenance	2	4	1	3	3	2	2
Mineral/Chemical Resistance	2	4	3	3	3	3	3
Appearance	3	4	2	3	3	2	2
Leak Resiliance	3	4	2	3	3	2	2
Installation	4	1	4	3	3	2	2
	22	26	19	22	22	18	20
Existing Finish Removal Required	yes	yes	partial prep	yes	yes	no	no

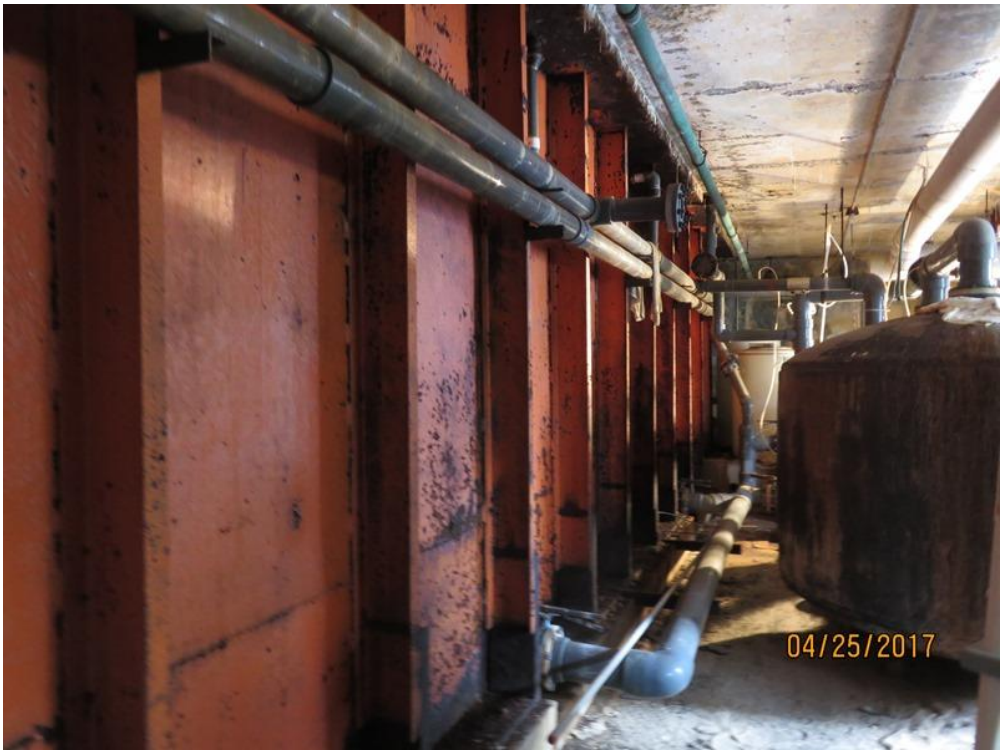
1 Poor
2 Fair
3 Good
4 Excellent

Appendix B

APPENDIX B
KNICKERBOCKER SWIMMING POOL – STRUCTURAL SUPPORT PHOTOGRAPHS

PHOTO No: 1	
LOCATION: Pool site,	
DESCRIPTION: General view of the swimming pool.	
PHOTO No: 2	
LOCATION: Exterior of filter building	
DESCRIPTION: General view of the filter building.	

APPENDIX B
KNICKERBOCKER SWIMMING POOL – STRUCTURAL SUPPORT PHOTOGRAPHS

PHOTO No: 3	
LOCATION: Filter room	
DESCRIPTION: General view of the interior of filter room.	
PHOTO No: 4	
LOCATION: Filter room – Exterior of pool wall	
DESCRIPTION: Corroded pool wall and pipe penetration connection. Up to 30% section loss.	

APPENDIX B
KNICKERBOCKER SWIMMING POOL – STRUCTURAL SUPPORT PHOTOGRAPHS

PHOTO No: 5	
LOCATION: Filter room – Pool wall	
DESCRIPTION: Pitting of base plate between steel channels.	
PHOTO No: 6	
LOCATION: Filter room – Pool wall at crawl space	
DESCRIPTION: Corroded channel. Up to 100% section loss.	

APPENDIX B
KNICKERBOCKER SWIMMING POOL – STRUCTURAL SUPPORT PHOTOGRAPHS

PHOTO No: 7	
LOCATION: Filter room – pool wall	
DESCRIPTION: Corroded channel. Up to 100% section loss.	
PHOTO No: 8	
LOCATION: Filter room – Pool wall	
DESCRIPTION: Severe corroded pool wall at the pipe penetration and damaged joint seal material.	

APPENDIX B
KNICKERBOCKER SWIMMING POOL – STRUCTURAL SUPPORT PHOTOGRAPHS

PHOTO No: 9	
LOCATION: Filter Room – Pool Wall	
DESCRIPTION: Corroded angle at the corner of the pool wall. Up to 80% section loss.	
PHOTO No: 10	
LOCATION: Filter Room – Pool wall	
DESCRIPTION: Corroded built-up beam below the concrete roof deck and behind the pool wall.	

APPENDIX B
KNICKERBOCKER SWIMMING POOL – STRUCTURAL SUPPORT PHOTOGRAPHS

PHOTO No:11	
LOCATION: Filter room – Concrete roof deck	
DESCRIPTION: Corroded wide flange beam under the concrete roof deck. Up to 10% section loss.	
PHOTO No: 12	
LOCATION: Filter room – Concrete roof deck	
DESCRIPTION: Large concrete spalls with exposed reinforcement at the underside of concrete roof deck.	

APPENDIX B
KNICKERBOCKER SWIMMING POOL – STRUCTURAL SUPPORT PHOTOGRAPHS

PHOTO No:13	
LOCATION: Filter room – Concrete roof deck at crawl space	
DESCRIPTION: Large concrete spalls with exposed reinforcement at the underside of concrete roof deck.	
PHOTO No: 14	
LOCATION: Filter building – Exterior wall and roof overhang	
DESCRIPTION: Large concrete spall on roof deck.	

APPENDIX B
KNICKERBOCKER SWIMMING POOL – STRUCTURAL SUPPORT PHOTOGRAPHS

PHOTO No: 15	
LOCATION: Filter building – Exterior wall and roof overhang	
DESCRIPTION: Wide cracks in concrete roof deck with efflorescence. Deteriorated window and window covering.	
PHOTO No: 16	
LOCATION: Pool site - Deck	
DESCRIPTION: Wide cracks and large opening in concrete deck.	

APPENDIX B
KNICKERBOCKER SWIMMING POOL – STRUCTURAL SUPPORT PHOTOGRAPHS

PHOTO No: 17	
LOCATION: Pool site - Deck	
DESCRIPTION: Large spall and delaminated concrete at previously patched locations.	
PHOTO No: 18	
LOCATION: Pool site - Stair	
DESCRIPTION: Detached concrete stair at base and peeling of protective paint.	

APPENDIX B
KNICKERBOCKER SWIMMING POOL – STRUCTURAL SUPPORT PHOTOGRAPHS

PHOTO No: 19	
LOCATION: Pool site – Pool floor	
DESCRIPTION: Bumping of pool floor	
PHOTO No: 20	
LOCATION: Amenities building	
DESCRIPTION: Wide stepped cracks in brick vaneer.	

APPENDIX B
KNICKERBOCKER SWIMMING POOL – STRUCTURAL SUPPORT PHOTOGRAPHS

PHOTO No: 21	
LOCATION: Facility building – Interior of building	
DESCRIPTION: Wide crack in load bearing CMU wall.	
PHOTO No: 22	
LOCATION: Facility building – Interior of building	
DESCRIPTION: Wide cracks in concrete slab-on-grade and finish floor tiles.	

APPENDIX B
KNICKERBOCKER SWIMMING POOL – STRUCTURAL SUPPORT PHOTOGRAPHS

PHOTO No: 23	
LOCATION: Facility building – Interior of building	
DESCRIPTION: Spalls in floor tiles.	
PHOTO No: 24	
LOCATION: Facility building – restroom	
DESCRIPTION: Corroded metal partition panel.	

Appendix C

City of Troy Knickerbocker Swimming Pool & Aquatic Equipment Upgrades

PRELIMINARY SUMMARY OF PROBABLE COSTS

(Estimated costs below have been compiled to provide a renovation for a minimum 5 year life expectancy.)

ITEM		DESCRIPTION	RATING (1-3)	QUANTITY	UNIT	UNIT PRICE	SUBTOTAL
1.0		**Pool Shell & Site Recommendations**					
	1a	Painted Finish	1	7,425	square foot	$ 4.50	$ 33,412.50
	1b	Plaster Finish	1	7,425	square foot	$ 10.95	$ 81,303.75
	2	Concrete Deck Replacement	1	10,900	square foot	$ 10.00	$ 109,000.00
	3	Underground Piping Repairs	1	1	lump sum	$ 20,000.00	$ 20,000.00
	4	Main Drains	n/a	2	each	$ -	$ -
	5	Pool Gutter Repairs	1	1	lot	$ 12,000.00	$ 12,000.00
	6	Wall Returns	1	20	each	$ 175.00	$ 3,500.00
	7	Water Slide	2	1	each	$ 12,000.00	$ 12,000.00
	8	Handicapped Access Lift	1	1	each	$ 6,500.00	$ 6,500.00
	9	Stair Rail	1	1	each	$ 1,750.00	$ 1,750.00
	10	Deck & Life Safety Equipment	1	1	lot	$ 13,500.00	$ 13,500.00
	11	Depth Markers	3	40	each	$ 145.00	$ 5,800.00
	12	Steel Pool Shell Repairs (per Structural findings)	1	1	lot	$ 33,120.00	$ 33,120.00
		SUBTOTAL #1 (with Painted Finish)					**$ 250,582.50**
		SUBTOTAL #1 (with Plaster Finish)					**$ 298,473.75**
2.0		**Pool Mechanical Room Equipment Recommendations**					
	1	Filtration System*	1	1	lump sum	$ 74,000.00	$ 74,000.00
	2	Recirculation Pumps*	1	2	each	$ 6,500.00	$ 13,000.00
	3	Strainer	1	2	each	$ 5,100.00	$ 10,200.00
	4	Pipe & Valve Replacements	1	1	lump sum	$ 17,000.00	$ 17,000.00
	5a	Chemical controller & flow cell*	1	1	each	$ 8,600.00	$ 8,600.00
	5b	Acid Metering pump*	1	1	lump sum	$ 3,100.00	$ 3,100.00
	5c	Cl Metering pump*	1	1	lump sum	$ 3,100.00	$ 3,100.00
	5d	Spill Containment	1	1	lump sum	$ 1,200.00	$ 1,200.00
	5e	Chemical Feed pipe/tubing replacement	1	1	lump sum	$ 2,800.00	$ 2,800.00
	6	Pipe Supports	1	10	each	$ 550.00	$ 5,500.00
	7	Flow sensor & meter	1	1	each	$ 5,500.00	$ 5,500.00
	8	Flow controller	1	1	each	$ 2,250.00	$ 2,250.00
	9	Check valve	3	2	each	$ 1,800.00	$ 3,600.00
		SUBTOTAL #2					**$ 149,850.00**
3.0		**Mechanical Room & Bathhouse Miscellaneous Improvements**					
	1	Electrical in Mechanical Room (GFCIs, Equipment controls/hook ups, etc.)	1	1	lump sum	$ 15,000.00	$ 15,000.00
	2	Structural Repairs in Mechanical Room (per Structural reporting & findings)	1	1	lump sum	$ 30,000.00	$ 30,000.00
	3	Cosmetic Repairs in Mechanical Room (Cracks in walls, backwash pit, Treat/Prime/Paint walls)	3	1	lump sum	$ 12,500.00	$ 12,500.00
	4	HVAC System Repairs	1	1	lump sum	$ 18,000.00	$ 18,000.00
	5	Amenities Bldg./Bathhouse Repairs	1	3,800	square foot	$ 90.00	$ 342,000.00
		SUBTOTAL #3					**$ 417,500.00**
4.0		**A/E Fees, Permitting**					
	A	Compliance Report					none expected
	B	Soft Costs (Engineering Design)					$ 124,322
	C	Permitting / Approval					$ 20,000
	D	General Conditions					$ 252,563
	E	Contingency					$ 126,282
	F	FF&E					$ 111,641
	G	On site Equipment Training					$ 2,500
	H	Construction Management Services**					TBD
		SUBTOTAL #4					**$ 637,308**
5.0		**Grand Totals (Rating #1)**					
		GRAND TOTAL w/ PAINTED FINISH					**$ 1,403,341**
		GRAND TOTAL w/ PLASTER FINISH					**$ 2,088,540**
6.0		**Grand Totals (Ratings #2) *** **					
		GRAND TOTAL w/ PAINTED FINISH					**$ 1,433,341**
		GRAND TOTAL w/ PLASTER FINISH					**$ 2,118,540**
7.0		**Grand Totals (Rating #3) **** **					
		GRAND TOTAL w/ PAINTED FINISH					**$ 1,455,241**
		GRAND TOTAL w/ PLASTER FINISH					**$ 2,140,440**
8.0		**New Construction**					
		Per Report section 8.0					**$ 3,755,000**

(* Assumes that there is sufficient electrical capacity in existing electrical system. To be verified during design.)

(** To be determined based upon client preference, scheduling and Contractor's on-site duration time.)

(*** This figure includes Rating #1 improvements.)

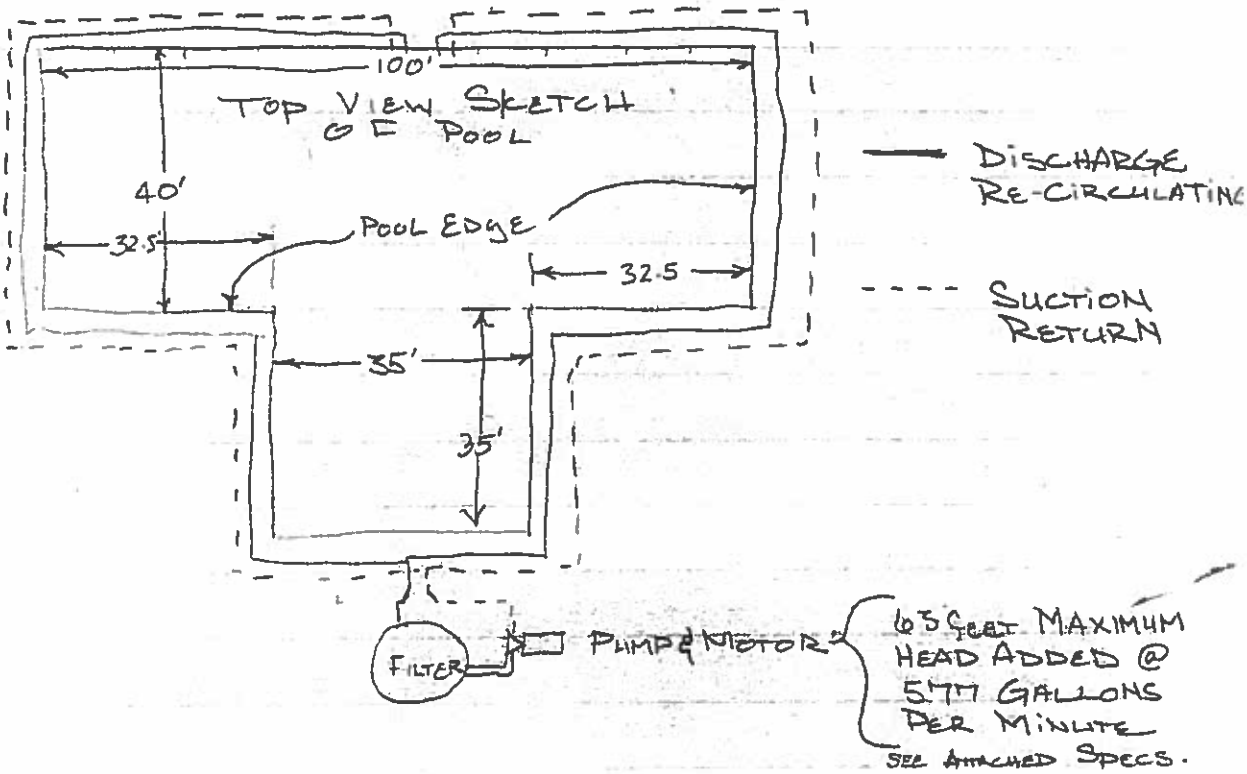
(**** This figure includes Rating #s 1 & 2 improvements.)

Appendix D

Knicks Pool Gallonage 207,000

Calculations For Loss of Head in Filter & Recirculating System

(All Calculations Based on Assumed +60°F)



Schedule of Fittings & Equivalent Length*1 Le

Size	Fitting	Le	Number	Total Le
	Discharge			
5"	90° Elbow	30	8	30 x 8 = 240
6"x5"x5"	(Flow Through Run) Standard Tee	20	1	20'
6"	90° Elbow	30	2	60'

Pipe Lengths

Discharge 5" —— 350'

Discharge 6" —— 25'

Pressure Drop in Devices

Hair & Lint Strainer - 0.9 PS

Filter*2 15-0 PS

x 2.31 Gives Head Loss

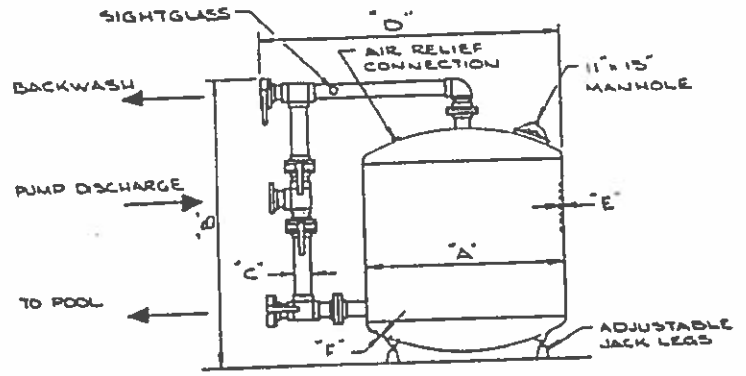
H & L Strainer — 2-08 Feet

Filter —— 34-65 Feet

*1 See Table Taken From "Applied Fluid Mechanics" R. Mott 2nd Ed.

*2 Source: Neptune Benson Inc- West Warwick R.I.

NEPTUNE RAPID FLOW FILTER SYSTEMS
FOR COMMERCIAL SERVICE



DIMENSIONS BASED ON:

STANDARD NON-CODE CONSTRUCTION

50 P.S.I. OPERATING PRESSURE
75 P.S.I. HYDROSTATIC TEST

TYPE A-36 CARBON STEEL HEAD AND SHELL

SCH. 40 PVC FACE PIPING

REFER TO SPECIFICATIONS FOR DETAILED DESCRIPTION AND DESIGN CRITERIA

ALL DIMENSIONS ARE APPROXIMATE AND SHOULD NOT BE USED FOR CONSTRUCTION PURPOSES

15 GPM./SQ. FT. RATE

FILTER MODEL NO.	MAX. POOL CAP. 6 HR. TURNOVER	MAX. POOL CAP. 8 HR. TURNOVER	TANK DIA. INCHES	FILTER AREA SQ. FT.	FLOW G.P.M.	DIMENSIONS A	B	C	D	E	F	EST. SHIP WT.
						CONSULT FACTORY						
30 SRF-2	26,640	35,520	30	4.91	74	36 3/8	80 1/4	3	57 1/4	3/16	3/16	577
36 SRF-3	38,160	50,880	36	7.07	106	42 3/8	81	3	63 1/4	3/16	3/16	673
42 SRF-3	51,840	69,120	42	9.62	144	48 3/8	82 1/2	3	69 1/4	3/16	3/16	780
48 SRF-3	68,040	90,720	48	12.6	189	54 3/8	86 1/4	4	77 3/4	3/16	1/4	1077
54 SRF-4	85,680	114,240	54	15.9	238	60 3/8	86 3/4	4	83 3/4	3/16	1/4	1200
60 SRF-4	105,840	141,120	60	19.6	294	66 1/2	86 1/4	4	89 3/4	1/4	1/4	1533
66 SRF-4	128,520	171,360	66	23.8	357	72 1/2	96	6	106 1/4	1/4	1/4	1819
72 SRF-6	152,640	203,520	72	28.3	424	78 1/2	97 3/4	6	112 1/4	1/4	5/16	2205
78 SRF-6	179,280	239,040	78	33.2	498	84 1/2	99 1/2	6	118 1/4	1/4	5/16	2447
84 SRF-6	207,720	276,960	84	38.5	577	90 1/2	101	6	124 1/4	1/4	5/16	2677
90 SRF-6	238,680	318,240	90	44.2	663	96 1/2	102 3/4	6	130 1/4	1/4	5/16	2921
96 SRF-6	271,800	362,400	96	50.3	755	102 3/8	104 1/2	6	136 1/4	5/16	5/8	3223
102 SRF-6	306,360	408,480	102	56.8	851	108 3/8	106	6	142 1/4	5/16	3/8	3583
108 SRF-6	343,440	457,920	108	63.6	954	114 3/8	108 1/4	6	148 1/4	5/16	3/8	4249
114 SRF-6	383,040	510,720	114	70.9	1064	120 3/8	113 1/2	8	162 1/2	5/16	3/8	4367
120 SRF-8	424,080	565,440	120	78.5	1178							

20 GPM./SQ. FT. RATE

FILTER MODEL NO.	MAX. POOL CAP. 6 HR. TURNOVER	MAX. POOL CAP. 8 HR. TURNOVER	TANK DIA. INCHES	FILTER AREA SQ. FT.	FLOW GPM	DIMENSIONS A	B	C	D	E	F	EST. SHIP WT.
						CONSULT FACTORY						
30 SRF-2	35,280	47,040	30	4.91	98	36 3/8	80 1/4	3	57 1/4	3/16	3/16	577
36 SRF-3	50,760	67,680	36	7.07	141	42 3/8	81	3	63 1/4	3/16	3/16	673
42 SRF-3	69,120	92,160	42	9.62	192	48 3/8	83 1/2	4	71 1/2	3/16	3/16	840
48 SRF-4	90,720	120,960	48	12.6	252	54 3/8	86 1/4	4	77 3/4	3/16	1/4	1077
54 SRF-4	114,480	152,640	54	15.9	318	60 3/8	86 3/4	4	83 3/4	3/16	1/4	1200
60 SRF-4	141,120	188,160	60	19.6	392	66 1/2	94 1/4	6	100	1/4	1/4	1644
66 SRF-6	171,360	228,480	66	23.8	476	72 1/2	96	6	106 1/4	1/4	1/4	1819
72 SRF-6	203,760	271,680	72	28.3	566	78 1/2	97 3/4	6	112 1/4	1/4	5/16	2205
78 SRF-6	239,040	318,720	78	33.2	664	84 1/2	99 1/2	6	118 1/4	1/4	5/16	2447
84 SRF-6	277,200	369,600	84	38.5	770	90 1/2	101	6	124 1/4	1/4	5/16	2677
90 SRF-6	318,240	424,320	90	44.2	884	96 1/2	108	8	138 1/4	1/4	5/16	3235
96 SRF-8	362,160	482,880	96	50.3	1006	102 3/8	109 3/4	8	144 1/4	5/16	3/8	3527
102 SRF-8	408,960	545,280	102	56.8	1136	108 3/8	111 1/4	8	150 1/4	5/16	3/8	3887
108 SRF-8	457,920	610,560	108	63.6	1272	114 3/8	113 1/2	8	156 1/4	5/16	3/8	4249
114 SRF-8	510,480	680,640	114	70.9	1418	120 3/8	115 1/2	8	162 1/2	5/16	3/8	4567
120 SRF-8	565,200	753,600	120	78.5	1570							

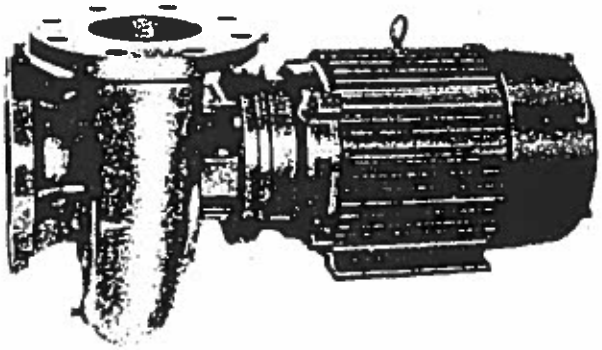
DRAWING NO. 44

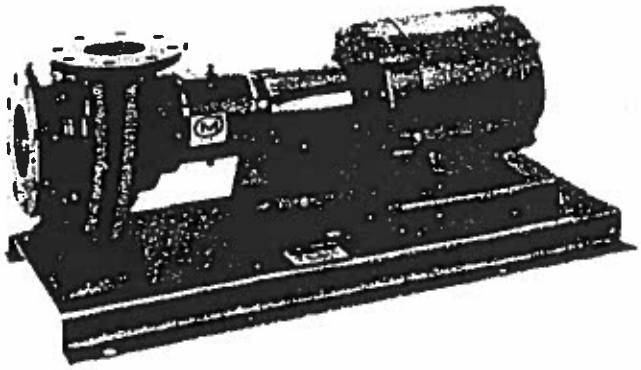
Specification data

ITT MARLOW
PUMPS AND COMPRESSORS DIVISION OF
INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION
MIDLAND PARK, NEW JERSEY 07432 • (201) 444-6900
LONGVIEW, TEXAS 75601 • (214) 753-7211

MODELS
XSL and XSC
YSL and YSC

MOTOR DRIVEN
HORIZONTAL, END SUCTION, SINGLE STAGE
STRAIGHT CENTRIFUGAL PUMPS





1 REQUIRED 15 HP; 570 GPM @ 62' TDH

MOTOR STARTERS NOT INCLUDED

Units are available long coupled "SL" or close coupled "SC" in cast iron or bronze fitted construction with back pull-out design. (All bronze construction available on 1¼ XSC, XSL, YSL and 1½ XSL and YSL models only.) Volute has integral supporting feet on long coupled models, ¼" NPT connections on suction and discharge, and vent and drain taps (1/8" on NPT connections). Volutes with 1¼" and 1½" connections are threaded NPT connections, all others are 125 # ASA flat faced flanges. Maximum case working pressure 200 PSI. On close-coupled models the discharge can be rotated in 45° increments on XSC series and 30° increments on YSC series.

Closed impeller, dynamically balanced, of cast iron or bronze, keyed and bolted to shaft. Impeller and volute design is such that discharge pressure does not act on seal faces.

Long-coupled units have high tensile strength steel shaft while close-coupled units have standard "C" flange register motor with carbon steel shaft (416 stainless steel optional on long coupled models at additional cost). Long-coupled shaft supported by grease lubricated single-row shielded ball bearings in cast iron housing supported with steel bracket at coupling end.

Self-lubricating single mechanical, shaft seal, consisting of ceramic, carbon, stainless steel and Buna N components. Replaceable bronze shaft sleeve. Packing construction available as an option on close-coupled models only.